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# Report to the Government

of

# THAILAND

on the

# DEVELOPMENT OF INLAND FISHERIES

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

ROME, 1957

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# REPORT

to the

# GOVERNMENT OF THAILAND

on the

# DEVELOPMENT OF INLAND FISHERIES

by

Shao-Wen Ling

FAO Fishery Biologist

Rome, 1957

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# INTRODUCTION

Thailand, although well known for her rich production of food (one of the leading exporters of rice), is still significantly deficient in animal protein. This especially affects the population of the North and North East Regions. Ways to remedy this situation must be found, and among the possible courses of action, a practical and economical way is to make better use of the inland waters for fish production.

Thailand has extensive inland waters - rivers, lakes, swamps, irrigation tanks, canals, rice fields, ponds and backwaters - of rather high production potential, but from which the amount of fish taken is relatively small. Inland fisheries consists chiefly of uncontrolled exploitation of wild stocks; there has been very little work on the management and conservation of the natural aquatic resources; stocking of fish in enclosed or open waters has seldom been practiced.

For many years, Dr. Hugh M. Smith, of the United States, served as fishery adviser to the Thai Government and recommended schemes for the development of the inland fisheries. However, no substantial results were obtained, possibly because of the lack of technical personnel and budget, although the Government has in recent years approved various projects in this field.

In 1948, FAO sent a special fisheries mission to Thailand to study the possibilities for fisheries development and the conditions under which advantage could be taken of these. The mission's report recommended a program for the development of inland fisheries by using management methods and cultural practices. During the next few years the FAO fishery officers attached to the FAO Regional Office for Asia and the Far East, Bangkok, assisted in preliminary work but it soon became obvious that the program required the full-time attention of someone fully qualified in this field. A request for such technical assistance from FAO was received from the Thai Government in January 1951, and a Supplemental Agreement for the provision of such assistance, through the Expanded Technical Assistance Program, was signed between the FAO and the Government of Thailand on 2 March 1951.

The principal objective of this project was to improve the exploitation of the inland fishery resources of Thailand, and where possible to actually develop them, in order to increase production of fish as food for the people. The expert was assigned to advise on and assist in:

a) improving and strengthening working facilities, and in training local technical personnel;
b) improving and developing the inland fishery resources, their management and utilization;
c) introducing and evolving practical methods and techniques for fish stocking and culture, and eradicating and controlling the growth of noxious aquatic plants and fish enemies;
d) planning and inaugurating basic biological investigations;
e) organizing an effective extension service to popularize fish stocking and culture among the public;
f) propagating and distributing stocking material;
g) giving practical technical aids.

The writer was seconded from the regular FAO program to undertake this project, and reported officially for duty to the Thai Ministry of Agriculture on 24 September 1951. The first assignment was for a period of one year. This, upon the request of the Thai Government, was extended twice; the assignment was terminated at the end of 1954.

## ACKNOWLEDGMENTS

The present report, while describing the ways in which the writer or TA expert, was able to give assistance to fishery officers of Thailand, is, of necessity, a comprehensive account of inland fishery activities in Thailand during the period of his assignment. It was a notable feature of the project that the expert became assimilated into the team of local workers, to whose integration he was able to make useful contributions. Descriptions of work and accomplishments appearing in this report, therefore, record the results of co-operative efforts of all the team members, to whom the expert expresses his sincere gratitude and thanks for their zealous co-operation.

Gratitude and thanks are due to the Thai Government officials for the unfailing support they gave to this project, which was an expression of their interest, and also for the invaluable personal encouragement and inspiration they gave to the team as a whole and to the writer in particular.

Appreciation and thanks are due to the FOA (US Foreign Operations Administration Mission to Thailand) for their valuable material support and technical co-operation.

Thanks are also due to officers of the Food and Agriculture Organization, both at its Headquarters, Rome, and its Regional Office, Bangkok, for wise direction and guidance, unfailing encouragement and assistance in making possible the rapid progress and successful completion of this project.

# I. BACKGROUND CONDITIONS OF INLAND FISHERIES IN THAILAND

## A. Topographical

The Kingdom of Thailand, extending from 5° N. to 21° N. and from 90° E. to 106° E., is a typical tropical country. It has a total area of about 580,000 square kilometers and a population of about 19 million. Topographically, Thailand may be divided into four natural regions: Northern, Northeastern, Central and Southern.

The Northern Region has an area of some 60,000 square miles and consists of a number of forest-clad mountain ranges. There are hills and valleys with good soil, which are intensively cultivated, rice being the principal crop. In some districts the irrigation system has been fairly well established, with the result that it is able to grow two agricultural crops a year. In this region, there exist many marshy lakes or swamps, covered with weeds, whose fish fauna consists of the common marsh fish and various small species of Cyprinidae.

The Northeastern Region, commonly known as the Korat area, is a saucer-shaped plateau tilted to the southeast. The soil is mostly of fine sandy loam, highly permeable to water and extremely low in plant nutrients. The region is flooded during the short rainy season but lacks water during the rest of the year. There are numerous swamps of various size, most of which are flooded during the wet season but which dry up during the dry season. The swamps and the few rivers and their tributaries are the chief source of fresh fish for the dense population of this region.

The Central Region is a vast and very gently sloping plain of about 55,000 square miles (the average drop in altitude is only about 0.16 meters per mile). It consists of the triangular delta of the Chao Phya River and tributaries, with numerous intersecting watercourses. Where the rivers Ping and Nan meet to form the Chao Phya, there is a huge marshy lake of more than 200 square kilometers, the Bung Borapet. Every year the Central plain is flooded during the monsoon. This flood is necessary for rice cultivation. When the streams rise and overflow their banks, fish follow the flood water, first into the canals and smaller streams, finally into the marshy swamps and paddy fields and the rest of the flooded areas which, as a whole, provide good feeding and spawning grounds. The inundation reaches its height at the end of the rainy season, and fishing starts when the flood begins to recede.

The Southern Region, sometimes called the Thai Peninsula, comprises the narrow part of the Malay Peninsula and a northern strip between Lower Burma and the Gulf of Thailand. In some places this strip is scarcely a dozen miles wide and slopes steeply from the mountains to the sea. Farther south, the region is sharply divided by the central range into eastern and western coastal tracts. The soil in general is composed of poor sandy and sandy clay loams, and in some places is saline. The big inland seas, Tonle-Sap and

Tonle-Noi, are important sources of supply of freshwater and brackishwater fish.

B. Hydrological and Climatic

The volume and distribution of the natural waters of a country and the climatic conditions, are factors which must be seriously studied in planning a program of development of fishery resources.

1. Inland waters

The Northern Region is drained by three great rivers: Menam Kong, Menam Chao Phya, and Mekong. Menam Kong drains the northwestern, western and southern parts of the region through its important tributaries Menam Pai, Menam Muc and Menam Yuam. Menam Chao Phya is formed by its two principal tributaries, Meping and Menam, which drain the central and eastern parts of the region. Two important streams, the Meing and Mekok, enter the Mekong along its short course where it forms part of the boundary between Thailand and Laos. The Kwan Payao is the largest of the swamps in this region. Since the completion of construction of the dam and water gates in 1941, this swamp is able to retain, throughout the year, a water surface of about 50 square kilometers, with an average depth of 2 meters.

The Northeastern Region has the great Mekong River as its natural boundary for the northern and eastern sections. The principal drainage is by the Menam Mun, a sizable stream which enters the Mekong from the west and has the Menam Chi as its main tributary. This supplies a large part of the plateau. In the eastern part there is the big Nong-harn swamp which has an area of about 170 square kilometers, and is both flooded and drained by the Menam Kam.

The Central Region is watered by Menam Chao Phya and its tributaries and collaterals, by the lower Meklong, lower Menam Petchaburi and Pran, Menam Bangpakong and Menam Prachin. Discharging into the Menam near its mouth, before joining Mepind to form the Menam Chao Phya, is the celebrated Bung Borapet swamp, which has been converted into a permanent lake by the construction of barrier bunds, and declared by the Government to be a fish conservation area. About 50 kilometers south of the City of Paknampo, the Menam Chao Phya splits into a number of large streams and forms a delta, which constitutes the vast plain of Ayuthia and Bangkok extending to the coast of the inner gulf.

The Southern Region has a large number of small streams and some fair sized rivers which drain its extensive mountains and plains. The large "inland sea," Tonle-Sap, which occupies an extensive plain on the east side of the southern part of the peninsula, consists of an inner lake of freshwater and an outer lake of brackishwater, and discharges

into the Gulf of Singora. The Tonle-Sap and the much smaller Tonle-Noi, which is connected with the northern arm of the Tonle-Sap, provide conditions very favorable for fish life.

Besides the rivers and streams, there are thousands of swamps, lakes and marshy depressions in Thailand. Most of them are flooded during rainy season and dried up during the dry season, but some retain water throughout the year. These natural waters vary greatly in size, ranging from less than 1 hectare to over 10,000 hectares. Practically all of them are densely overgrown with aquatic weeds, but possess a high productive potential and, therefore, constitute the principal water regime for fisheries development.

The Thai Government's gigantic irrigation scheme for the northeast proposes the construction of more than 120 irrigation tanks with a total water surface area of over 40,000 hectares. These tanks provide good habitat for fish.

2. Climate and weather

In the northern valleys, which are far from the coast and shut in by mountains, the temperature is generally high but fluctuates considerably - sometimes exceeding 38°C. in summer and frequently falling to 10°C. in winter. In the south, the temperature is milder and with less variation, seldom exceeding 32°C. and rarely falling below 15°C. The warmest season is between March and May.

There are two pronounced seasonal wind shifts, known as Northwest Monsoon and Southwest Monsoon. The Northeast Monsoon commences to blow from the North China Sea late in September and invades Thailand from November to February; it is comparatively dry and cold and brings an appreciable amount of rain to the East Coast of southern Thailand. The Southwest Monsoon is a moisture-laden air current which brings rain to most of Thailand from May to September. The dry season is from November to April.

Along the East Coast there is a second rainy season from October to January. The rain often comes in afternoon squalls. On the western windward slopes and mountain exposures the rainfall may reach 3,000 mm. annually, but much of Thailand receives hardly more than 1,000 mm. and some localities scarcely 750 mm.

Floods occur every year in different parts of the country. The so-called annual floods, which occur from July to November, are the results of the heavy rain and slow discharge during the Northwest Monsoon.

C. Biological

The inland aquatic resources of Thailand are abundant and varied. In general, the flora and fauna of the waters closely resemble those of Burma, Laos, Cambodia and Viet-Nam and other neighbouring nations.

Common aquatic plants include (1) floating types: Eichlornia crassipes, Pistia stratiotes, Lemna, Azolla, Salvinia, Jussiaea, Sphenoclea, Neptunia, Marsillia, Trapa, Ipomoea, etc.: (2) submerged types: Ceratophyllum, Utricularia, Hydrilla, Cabomba, Najas, etc.: (3) emergent types: Scirpus, Cyperus, Ceratopteris, Limnanthemum, Nymphaea, Nelumbo, etc. Among them Eichlornia crassipes, the water hyacinth, is a principally noxious plant, growing profusely in all the inland waters of the Kingdom. Ipomoea has been widely used as food.

The aquatic fauna of Thailand has been extensively studied by Smith and others. Smith's work on the "Freshwater Fishes of Thailand" is the standard reference on this subject.

Members of the carp family (Cyprinidae) are the most numerous species of fish in Thailand waters. Some representatives of this family occur wherever there is sufficient water to support fish life. Important genera are Puntius, Osteochilus, Dangila, Cirrhina, Cyclocheilichthys, Leptobarbus and Catlacarpio.

Next in importance are the fish known as catfish (Siluroid fish), of which the important genera are Clarias, Wallago, Cryptopterus and Pangasius. Most of these are highly esteemed and consumed in great quantities.

Snakeheads (Ophicephalus) dominate in swamps, tanks, klongs, rice fields and ponds, doubtless because of their strong carnivorous habits, and their ability to live in very shallow water, or even out of water, for protracted periods. Other fish, especially the weaker herbivorous species, find it difficult to flourish where snakeheads abound.

The interesting and valuable labyrinth fish are represented by the "climbing perch" (Anabas testudineus), the Sepat Siam or pla salid (Trichogaster pectoralis), the giant gourami (Osphronemus goramy), and the "kissing gourami" (Helostoma temminckii). Except the Anabas, the other species mentioned are excellent for stocking and culture.

Inland fishing operations have consisted only of exploitation of wild stocks, in the rivers, canals, swamps and other bodies of water. The gear commonly used consists of cast, scoop and dip nets, rod and lines, gill and bag nets, traps of different sizes and designs, etc. Where waters discharge through narrow passages, various types of barriers, some constructed completely across the passage, are used to catch fish. Fine-meshed dip nets are used, either from boats or from the banks, to catch the small cyprinid fish "pla soi" during their annual upstream migration by the million. Almost every family living along the streams owns fishing gear and engages in subsistence fishing.

The vast network of rivers and streams, the great acreage of swamps, rice fields, tanks, ponds and flooded areas, the annual flood with its huge amount of fertile silt, the abundant fish fauna and the warm climate signify a rich potential for fish production. On the other hand, the long dry season

and quick reduction in water volume, the excessive growth of noxious aquatic plants, and the dominance of predators, are strong factors tending to keep actual production below the potential. These opposing natural forces have established a rather stable ecological balance. The resultant production is, from some standpoints, very low and it seems that an increase could be effected only by disturbing the existing ecological system through human intervention in the following ways:

a) by eradication of noxious plants to provide more space for fish growth;
b) by catching predators, thus providing a better opportunity for the weaker, herbivorous species to grow;
c) by providing suitable protection for the wild stock;
d) by simple stocking operations to increase the abundance of desirable species;
e) by construction of water controls to maintain water for longer periods;
f) by introduction and development of fish culture practices.

## II. PRINCIPAL PROBLEMS AND PROGRESS TOWARD THEIR SOLUTION

### A. Improving Facilities and Training Technical Personnel

#### 1. Development of existing fisheries stations

There are six fisheries stations: four for inland waters, one for brackish water and one for marine. The four inland stations are: (1) Banghken (Central Station near Bangkok); (2) Bung Borapet (Central Plain); (3) Kwan Payao (North) and (4) Nong Harn (North East). The brackish water station is located at Klongwan, Prachuab, on the east coast of the Gulf of Thailand.

The Banghken Fisheries Station is located in the Central Agriculture Experimental Center, Banghken, and is managed co-operatively by the Agriculture University and the Department of Fisheries. This station has about 100 fish ponds of various sizes, office, laboratory, aquarium and storage buildings, living quarters for officers and workers, and a few assorted hatchery facilities and field equipment. The laboratory has been especially equipped for teaching and training.

The other three inland fisheries stations are provided with the same kind of physical establishment and facilities, except that each has control and management of a big swamp which has been converted into a lake.

Ambitious schemes were made in which stations were to conduct fisheries surveys, limnological investigations and fish culture experiments. Unfortunately, because of the lack of technical personnel, equipment and facilities, and also because the work program was not properly planned, only limited progress was achieved.

The writer made a careful study of the various stations, interviewed the technical personnel and analyzed the work program. Suggestions for improvement were made, mainly along lines to enable the stations to play active roles in the promotion of fish stocking and culture, the conduct of basic investigations and experiments for improving fish culture techniques, and better management and fuller use of inland waters for increasing fish production.

All available existing ponds, tanks and hatchery facilities were improved, repaired or converted and are now fully employed for production of stocking material and experimental purposes. New ponds and facilities have been added where the need was justified.

A set of basic equipment for inland fisheries survey and fish culture studies has been supplied by FAO for training and demonstration purposes. Hatchery equipment, field and transport facilities and instructive literature were supplied by the U.S. Foreign Operations Administration Mission to Thailand.

All technical officers of the stations received training from the expert and those competent have been selected to be the chiefs of the stations or to take over important technical responsibilities.

2. Development of extension service

The Fisheries Extension Service Section of the Fisheries Department was in poor circumstances, staffed with only two officers, provided with no transport facilities, no field equipment, and with only a very small budget.

In these circumstances the extension officers were mostly confined to doing paper work in the office and had little contact with the public, and technical service was limited to assisting the fish farmers to import Chinese carp fry from Hong Kong.

Realizing the imperative need for a strong extension service section with a well-planned program to implement the inland fisheries development project, the writer had discussions with the Director-General of the Thai Fisheries Department and his Chief of the Fish Culture Division and Chief of Extension Service. Suggestions for development of the services were carefully considered and when agreed upon were implemented along the following lines:

a) The staff section was increased, and the expert gave all of them basic training in the planning and conduct of extension services.
b) All officers on extension service are now required to go to the people and give assistance, instead of working at the office and waiting for the fish farmers to come for advice.
c) Adequate transport facilities and field service equipment have been provided.
d) A special budget has been allocated.
e) All fisheries stations have been instructed to co-operate and serve as field extension service units for their respective localities.
f) Adequate hatchery facilities have been provided for all the fisheries stations to increase the production of stocking material for distribution.
g) The Extension Service Section is responsible for co-ordinating all extension activities, collecting and disseminating information, preparing and issuing extension pamphlets, posters and popular articles on fish culture, preparing and setting up exhibitions and demonstrations at public functions and giving public lectures and radio talks, as well as issuing releases.
h) Field service teams have been organized, and each is provided with the necessary transport facilities and field equipment for giving direct assistance to the people.

3. Establishment of field stations

Seven new fisheries field stations have been established at strategic localities to provide effective extension services for the whole Kingdom and to supplement the existing fisheries stations. The seven localities, Maecho (North), Patalung (South, Nakornrajsima (Korat), Khorn-Kaen (North-east), Udorn Tarni (Northeast), Mahasarakham (North-east) and Ubol (Northeast) were selected because of the need for such stations in those areas, for their physical suitability and possibilities for further extension. Five of the field stations were established in the Northeast Region because this is far from the sea, has a very large population and a very poor supply of fish.

At present all these field stations are operated on a small scale. Their purpose is to:

a) spread knowledge on fish stock and culture;
b) conduct fish stocking and culture operations;
c) produce and supply stocking material and
d) develop swamps and irrigation tanks for increasing production of fish.

Each station is staffed with one or two technical officers and some laborers. Simple wooden buildings were constructed to provide office, work space and living accommodation. Ponds were constructed, chiefly to increase production of stocking material, but some are used as demonstration fish ponds. The necessary tools and gear, field equipment and transport facilities were supplied, directly or indirectly, by the Fisheries Department.

Tilapia, common carp and pla salid, are now being produced for distribution. It is expected that other fish, such as Puntius, giant gouramy and kissing gouramy, will be produced in the near future.



| Fisheries Field Station | |
|---|---|
| Maecho | |
| Nakornraj | |
| Khorn-kae | |
| Udorn | |
| Mahasarak | |
| Patalung | |
| Ubol | |

# INFORMATION ON FISHERIES FIELD STATIONS

(DECEMBER, 1954)

| Locality | Officer-in-Charge | Construction started | No. of Bldgs. constructed | Ponds constructed | | Supply of stocking material | |
|---|---|---|---|---|---|---|---|
| | | | | No. | total area ha. | date started | total no. distributed (approx.) |
| Maecho (north) | Duang Techakomol | Oct. 1952 | 2 | 16 | 2 | April 1953 | 550,000 |
| Korat (n.east) | Bunlee Laksanahputra | Sept.1953 | 2 | 12 | 0.5 | April 1954 | 150,000 |
| Khorn-kaen (n.east) | Songsilpa Suteharitkul | Oct. 1953 | 1 | 10 | 0.7 | July 1954 | 50,000 |
| Udorntarni | Wisootti Wacharakool | April 1954 | 2 | 20 | 3 | Nov. 1954 | 20,000 |
| Mahasara-tham (n.east) | Samran Dhamrongratana | Sept. 1953 | 3 | 24 | 0.6 | Expected to start Spring 1955 | - |
| Patalung (south) | Dhon Sritachit | Jan. 1954 | 4 | 5 | 0.5 | idem | - |
| Ubol (n.east) | Uthai Prommintra | Nov. 1954 | 1 | 6 | 0.5 | idem | - |

4. Training of technical personnel

The Fisheries Department had a rather large staff but few were technically competent. Officers in charge of inland fisheries activities were chiefly men with general school education and some training in general fisheries obtained in the Department; there were some graduates of the fisheries course of the Agriculture University, and a few who had had some advanced technical training abroad. To help reduce the serious lack of technically competent personnel, training schemes were started by the expert.

Apart from the great differences in basic scientific education, there were also differences in age, length of service, practical experience and ability of the officers. It has, therefore, been rather difficult to provide such a heterogeneous group with technical training, and the training methods used could not, perforce, be rigid or conventional. At the same time, while training in practical technical matters has been the principal objective, efforts have also been made to encourage and develop the interest and working spirit of the trainees, and this in turn has produced important results.

At first, considerable effort was spent on trying to train the officers to conduct basic investigations and experiments but, when it was realized that they were not ready for such work, training was focused mainly on practical fish culture and fish stocking operations.

Four main categories of training have been given:

a) On-the-job training;
b) General training in fish culture;
c) Field-study tour;
d) FAO fellowships for training abroad.

a) "On-the-job" training

This type of training has been given to all fisheries officers of the stations during the visits of the expert, and to the staff of the Fish Culture Division, especially to officers of the Extension Service Section. The principal subjects included: basic principles of fish culture; stocking of fish in natural waters; planning and conducting fisheries field surveys extension service, etc., and the analysis of problems encountered by the fisheries officers.

During the visit of the expert to each station, all technical officers were called together for discussion and study sessions. Technical activities of the station were examined, analyzed and commented upon, and the success or failure of work discussed. Suggestions for improvement of, or introduction of more efficient methods and procedure were made, with practical demonstrations when necessary. Methods of field observations and studies were taught and followed by practical exercises conducted at the station and at nearby bodies of natural waters. Principles and practice of extension service were explained, schemes for starting them were formulated and procedures for implementing them outlined, then put into practice.

b) General training in fish culture

A general training course in fish culture was organized to equip the inland fisheries officers with the basic knowledge and skill to undertake practical operations, render extension services and conduct simple experiments in fish stocking and culture.

Subjects in which instruction was given include: general biology of species of fish suitable for stocking and culture; principles of limnology in relation to fish stocking and culture operations (including studies on the physical, chemical and biological conditions of ponds and natural waters); principles and practices on fish stocking and culture operation (swamp, irrigation tanks improvement, pond construction and management, fertilizing pond waters, elimination of predators and fish enemies, eradication of noxious weeds, breeding of fish, rearing and care of fry and fingerlings, stocking and culture of fish, transport of stocking material, etc.); and principles and practices in conducting extension services.

Most of the instruction was given in English by the expert and translated into Thai by senior Thai fisheries officers. Classroom lectures and discussions, laboratory exercises, and practical field work received equal attention.

Two sessions of this training course, each lasting for a period of six and one-half weeks, were conducted at the Banghkan Fisheries Station, Bangkok, with Mr. Boon Indrambarya, Director-General of the Thai Fisheries Department as Director, the writer as technical adviser and chief instructor, and senior Thai fisheries officers as instructors and assistants. Fisheries officers of both the FAO Regional Office for Asia and the Far East and of the U.S. Foreign Operations Mission to Thailand gave special lectures. Trainees were selected from among the officers of the fisheries stations, fisheries officers working in provinces and districts, and teachers of agricultural vocational schools.

The first session of the training course was conducted during September-October 1952, with twelve full-time trainees and two observers. The second session took place during May-July 1953, with twenty-five trainees and one observer, including two fisheries officers from Viet-Nam and one from Burma, who participated as full-time trainees. The course was officially opened and closed by H.E. the Minister of Agriculture, and attended by many senior officers and staff of the Ministry of Agriculture, the Fisheries Department, the Agriculture University, the U.S. Foreign Operations Mission and FAO.

As a result of the close co-operation among the teachers, administrative staff and the trainees, and because of the simple and direct approach in conducting the training, trainees of both sessions received basic practical knowledge sufficient to enable them to carry out efficiently active fish stocking and culture extension schemes in their respective duty stations.

List of Trainees who Completed Training During the First Session of the General Fish Culture Training Course

| | Name | Present official position |
|---|---|---|
| 1. | Chin Rasananda | Head, Nong-Harn Fisheries Station |
| 2. | Dhon Sitachitta | Head, Patalung Fisheries Station |
| 3. | Duang Tejakomol | Head, Maccho Fisheries Field Station |
| 4. | Eang Ngourungsi | Provincial Fisheries Officer, Nakorn-srithamraj. |
| 5. | Uthai Suntarotok | Acting Head, Klongwan Brackish Water Fisheries Station. |
| 6. | Oudorn Sukathat | Acting Head, Fishery Co-operative Section |
| 7. | Rob Nilakuha | Provincial Fisheries Officer, Prachuab. |
| 8. | Sanun Ruamruksa | Technical Officer, Division of Fisheries Investigation. |
| 9. | Songsilpa Sutcharitikul | Head, Khorn-Kaen Fisheries Field Station. |
| 10. | Uthai Prommintra | Head, Ubol Fisheries Field Station. |
| 11. | Wisootti Wacharakool | Head, Udorn Fisheries Field Station. |
| 12. | Boonlue Somboonvongse | Assistant Fisheries Officer, Maccho Fisheries Field Station. |

List of Trainees who Completed Training During the

Second Session of the General Fish Culture Training Course (Continued)

A - Thai Fisheries Officers

| | Name | Present official position |
|---|---|---|
| 1. | Boonlee Laksanahputra | Head, Fisheries Field Station |
| 2. | Boonlert Klyprahong | Assistant Fisheries Officer, Bangkhen Station. |
| 3. | Chanid Purnapura | Provincial Fisheries Officer, Paknam |
| 4. | Chern Prayoonphokaraj | District Fisheries Officer, Surat Province. |
| 5. | Chart Tapanonda | District Fisheries Officer, Smutsakorn |
| 6. | Chiab Ratanasona | Assistant Fisheries Extension Service Officer. |
| 7. | Dharm Tesna | Assistant Fish Culture Officer |
| 8. | Kitcha Promohotikul | Assistant, Fisheries Administration Division. |
| 9. | Phit Talakoon | Provincial Fisheries Officer, Smutsongkhram. |
| 10. | Paibool Puntasen | Assistant in Fish Culture |
| 11. | Praphas Nitayachinta | Assistant in Fish Culture |
| 12. | Sathit Catawalh | Assistant Fisheries Officer Patalung Fisheries Field Station |
| 13. | Sira Prasart | Provincial Fisheries Officer, Pichit |
| 14. | Siri Chantanasiri | Provincial Fisheries Officer, Cha-Choeng-Sou. |
| 15. | Surindra Chantanasiri | Assistant, Brackishwater Fisheries Station |
| 16. | Thavi Boonprasert | District Fisheries Officer, Chumporn |
| 17. | Wai Pilyo | Technical Fisheries Officer, Division of Fisheries Investigation. |

B - Thai Agriculture School Teachers

| Name | Present position |
|---|---|
| 1. Chamlong Marlawongse | Instructor, Suring Provincial Agriculture Vocational School |
| 2. Khin Srijarphai | Instructor, Provincial Agriculture School, Nakorn Pathom |
| 3. Raum Chantajon | Instructor, Provincial Agriculture School, Galasinthu |
| 4. Sompetcha Vunnasiri | Instructor, Provincial Agriculture School, Buriram |
| 5. Watana Pahoolrat | Instructor, Provincial Agriculture School, Nakornsrithamaraj |

C - Fisheries Officers from Viet-Nam

| Name | Present position |
|---|---|
| 1. Cao Thien Buu | Fisheries Officer, in charge of South Viet-Nam |
| 2. Le Van Dang | Fisheries Officer, in charge of North Viet-Nam |

D - Fisheries Officer from Burma

| Name | Present position |
|---|---|
| 1. U Kyaw Nyi | Fisheries Biologist, Bureau of Fisheries, Burma. |

c) Field-study tour

A four-week field study tour was sponsored and financed by the U.S. Foreign Operations Mission in collaboration with the present FAO project, for a group of selected inland fisheries officers who were thus enabled to make first-hand observations and studies of fish stocking and culture operations practised in Indonesia and Malaya. The tour took place during September 1954, with the writer as technical adviser. The members of the tour are shown below.

List of Thai Fisheries Officers participating in the Study Tour

| | Name | Present position |
|---|---|---|
| 1. | Prida Karnasut | Chief, Fish Culture Division (Leader of the Group) |
| 2. | Chin Rasanonda | Head, Nong Harn Fisheries Station |
| 3. | Dhon Sritachit | Head, Patalung Fisheries Station |
| 4. | Samran Damrongratna | Head, Mahasarakarn Fisheries Station |
| 5. | Phairode Lipikorn | Head, Extension Service Section |
| 6. | Songsilpa Sucharitkul | Head, Khongan Fisheries Station |
| 7. | Uthai Sundarothoke | Acting Head, Brackishwater Fisheries Station |

Fish culture centers, both freshwater and brackishwater, in Djakarta, Bogor, Sukabumi, Bandung, Semarang, Djokjakarta, Surabaya, Singapore, Penang and Ipo, were visited, and fish culture practices, extension service activities, Chanos fry collecting and fry market organization and operations, were studied.

Discussion sessions were frequently held, in the evenings, to clarify and review what had been observed and studied during the day and also to provide briefing on what was to be seen on the following day.

Apart from the useful technical knowledge gained during the tour, the fish farmers and fisheries officers of the places visited showed a working spirit which provided an invaluable example for the Thai officers.

d) FAO fellowships for training abroad

As part of the terms agreed upon under the present FAO project, fellowships have been provided for qualified Thai fisheries officers to make advanced studies in the field of fish culture at suitable institutions in the Indo-Pacific Region. Four senior Thai fisheries officers were awarded fellowships at the FAO-sponsored Indonesian Fish Culture Seminar, one during the first session and three during the second session. These candidates had worked under the FAO expert and had received practical training from him before they went to the seminars. All the trainees completed their training satisfactorily, and upon their return were appointed to important posts on the inland fisheries.

## List of Thai Fisheries Officers

## Awarded ETAP Fellowships

| Name | Previous fisheries training | Type of training received under ETAP fellowship | Present position | Remarks |
|---|---|---|---|---|
| 1. Jinda Thiemmedh | B.S. in fisheries University of Philippines | FAO-Indonesian Fish Culture Seminar - 1st session | Head, Fish Section, Fisheries Department and Supervisor, Brackish-water Fisheries Station | Studied under Prof. H. Swingle at the Alabama Polytechnic Institute |
| 2. Ariya Sidhthimunka | Diploma in Fisheries Bangkhen Agriculture University | " " " " " - 2nd session | Head, Bangkhen Fisheries Station | Same as above |
| 3. Umphol Pongsuvan | " " " " " | " " " " " | Head, Bung Borapet Fisheries Station | Transferred to be Head of Bangkhen Fisheries Station |
| 4. Mek Boon-Brahm | " " " " " | " " " " " | Instructor, Fisheries Course, Bangkhen Agriculture University | Formerly, Head of Kwan Payao Fisheries Station |



FAO/57/6/4117

B. Evolving and Improving Technical Methods and Procedures

It is perhaps advisable to reiterate and emphasize that the work reported in this section was that of the team of which the writer became a member.

1. Better use of potential productivity

a) Improving methods of fishing in flooded areas

Fishing activities in the flooded areas may roughly be classified into two types: "Licensed fishing" and "monopoly fishing."

Licensed fishing may be done in all the flooded areas except those marked for monopoly fishing by anyone who has obtained a licence for his fishing gear (general restricted to hand nets, cast nets, simple traps and rod and line). Certain flooded swampy areas, sections of canals, and streams are marked for monopoly fishing. Usually each of these areas covers several thousand hectares of ground. The rights to fish them are auctioned by the Government to private individuals for a specified length of time. Fishing is done usually by placing V-shaped barriers across the narrow passages through which the flood waters recede. A catch chamber bag is attached at the bottom of the V to collect the fish. The barriers are often made of fine-meshed bamboo fence, or even cotton netting, and fish of all kinds and sizes are caught without discrimination. The destructive effect on the fish stock is obvious. Furthermore, during the peak fishing period, so many more fish are caught than can be handled that tons and tons of smaller fish are thrown on the shore and wasted. At the same time, farmers engaged in licensed fishing downstream cannot get enough even for their own consumption.

Although more detailed scientific study must be made of this situation, the following simple improvement was tested with encouraging results at Nong Moh, one of the well-known monopoly fishing areas.

In place of the V-shaped barrier, a bamboo screen barrier, with a 1½ inch mesh, was constructed to keep the big fish inside but allow the young fish to escape. At the same time, instead of giving the fishing rights to one private person, all farmers of the nearby villages who agreed to co-operate in taking care of the fence and in keeping the fishing area free from noxious plants, etc., were allowed to fish in the water under license. This change from monopoly fishing to licensed fishing, produced the following results: (1) jobs were provided for about one thousand village people instead of for only the single lessee and a dozen or so of his employees; (2) the small fish passed through the fence and presumably continue to grow and at best form part of the catch for the people living downstream; (3) because of the large number of persons engaged in the fishing all the fish caught were easily handled without any waste, even during the peak period; (4) the restrictions on gear use presumably had some effect on the fish stocks principally by prolongation of the fishing period.

b) Improving and extending the use of swamps and irrigation tanks to increase fish production

i. The swamps

There exist in Thailand several thousand swamps, ranging in size from one to several thousand hectares, making a total of more than 500,000 hectares in surface area. Many of these swamps are potentially rich productive grounds for fish, but few have been used fully for this purpose. The wild stocks of the swamps are fished quite extensively by local people, but no action has been taken to protect the stock, or to restock.

Many of the swamps are thickly covered with shrubs, grasses, and floating plants, and are overgrown with submerged weeds, which greatly reduce the area available for fish.

The sources of water supply are mainly rain and flood, and only a few of the swamps are protected by well-formed banks so that, during the rainy season, many of them are flooded, while during the dry season their area is greatly reduced, and they may even dry up completely.

The fish fauna of these swamps is dominated by predatory species such as Ophicephalus, Clarias, Notopterus and Wallago, while the herbivorous species are mostly carp of small size. This condition, plus the presence of a dense growth of aquatic plants, seems to indicate that a considerable proportion of the natural foodstuffs has not been used.

Intervention in the established ecological balance of these swamps to increase fish production has been developed in the following ways: (1) by removing weeds to increase the area in which fish and fish food may grow; (2) by constructing simple bunds across the gaps to maintain water level for a longer period; (3) by catching predatory species and thus allowing other fish to grow; (4) stocking with suitable non-predatory species.

Eradication of unwanted aquatic plants. Manpower has been used to remove weeds. This is done in small swamps by using bamboo poles fitted with hooks. The weeds are piled along the bank to decay and be converted into fertilizers for the swamp. In big swamps, besides pulling the weeds ashore with poles, masses of floating weeds are cut into blocks and pushed to places where they can be carried away by the current.

Application of 2,4-D has been successful in killing water hyacinth in the big swamps of Borapet, Kwan Payao and Nong-Harn. However, since powerful sprayers and repeated applications of the chemical are necessary to be effective, this method has not yet been commonly adopted.

Stocking with plant eaters, such as Puntius and giant gouramy, has also been done in some waters. But the number of fish stocked is rather small, hence no significant result has yet been observed, It is to be noted here that more efficient aquatic plant-eating fish, when found, will not only provide protein-rich food, but will also help keep the swamps comparatively clean and suitable for other table fish.

Use of water hyacinth and some submerged plants as fodder for pigs and other domestic animals has been encouraged and has also helped to reduce the mass of weeds in the swamps.

Mechanical aquatic weed cutters have been supplied by F.O.A., the U.S. Foreign Operations Administration, but as the operation and maintenance of them requires some mechanical skill and experience, they have not yet been put into use.

Construction of simple bunds. Almost every swamp has an open connection through which water flows out rapidly, so that during the dry season the water surface area and volume are greatly reduced. The construction of simple mud bunds across the gaps has enabled the swamps to retain water for a longer period.

Small mud bunds are constructed, mostly by the village people themselves, under the supervision of local civil officers, with material, financial and technical aids from the Government. Larger bunds are constructed by the people with co-operation from the experienced engineers of the Irrigation Department.

Reducing predatory fish and fish enemies. The common predator fish, such as snakeheads and fish enemies such as crocodiles, are greedy fish eaters. Their presence has greatly reduced the chances for the plankton and plant feeders, especially the young fish, to survive and grow. Regulations which restricted the catching of such predators have been abolished, and the people of farm villages are encouraged to catch as many predators as they can. Fish hooks, lines and traps have, in some cases, been given to the people for such purposes.

Stocking operations. In the case of big swamps, the construction of mud bunds and removal of weeds are usually effective enough to bring about an appreciable increase in fish production. However, fast-growing and self-propagating species, with plankton and plant feeding habits, such as Trichogaster, Tilapia and Puntius, have been used for stocking when this is considered desirable. The fry and fingerlings have been produced by the government fisheries stations, transported to the swamps by special trucks and released into the swamps in the presence of the village people.

Results of the many simple stocking operations show that Trichogaster pectoralis adapts well to the swamps and reproduces and spreads quickly, but Tilapia mossambica has not yet been

observed to be able to stand up against the predators and become really established. Fingerlings of less than 6 cm. in length are often quickly eaten by the predators, but those above 10 cm. long have a better chance to survive and become established.

Examples of swamp improvement. Two examples may be cited.

The large swamp of Boong Gluea is located in the District of Seraphumi, Roi-et Province, with about 5,000 people living around it in four villages.

Before improvement, the swamp had a water surface area of about 2,000 hectares during the rainy season, but less than 100 hectares during the dry season because of runoff through several big gaps. There was an excessive growth of aquatic plants. The water was so shallow and turbid and the temperature was so high in the dry season that most of the fish in it died. The annual catch of fish was estimated to be about 50,000 kg.

Village people were organized to co-operate in constructing mud bunds about 100 meters long, to block up the four gaps, removing noxious plants, especially the water hyacinth, maintaining the swamp and keeping the agreed regulations governing fishing activities and fishing gear.

After improvement, the swamp is now able to retain about 2,000 hectares of water during the rainy season and about 1,000 hectares during the dry season, with only small quantities of water hyacinth and practically no excessive growth of submerged plants. People of the nearby villages are allowed to fish according to the agreed rules and regulations. The present annual catch of fish is estimated to be 100,000 kg. Besides the 100 per cent increase in production of fish, the swamp can now provide farmers with a supply of water for domestic purposes throughout the year.

In making further improvements, the following actions are to be taken: ) draining fertile water from the paddy fields and the villages into the swamp, increasing the catch of predators, and stocking the swamp with fast growing and self-propagating fish which feed on plant and plankton.

The work done at Nong Khae is illustrative of that which may be accomplished at a typical small swamp. There are 93 families, with a total population of 600 persons, living around it.

Before improvement, the swamp had a water area of about 10 hectares during flood season and was completely dried up during the dry season. About 400 kg. of fish, consisting mostly of small carp, snakeheads, cat fish and climbing perch, were caught every year.

People living around the swamp were organized by the village chief, under the supervision of fisheries officers, to construct a mud bund to block the wide outlet completely, remove weeds and predators, and construct simple drainage to direct part of the village's sewage into the swamp. About 120 pairs of mature Sepat Siam and 100 pairs of mature Tilapia were stocked during the autumn of 1951. An area of about 50 square miles at the center of the swamp was planted with Impomoea and some dead branches, and reserved as a fish sanctuary.

Since the conversion, the swamp has become a big fish pond, able to maintain a water surface area of about 10 hectares during the flood and 6 hectares during dry seasons. It is free from noxious plants, and is very rich in plankton.

During the spring of 1953, about one and a half years after stocking, collective fishing was organized and the amount of fish caught was as follows:

| Name of fish | Number | Approximate weight (kg.) |
|---|---|---|
| Trichogaster | 50,000 | 6,000 |
| Ophicephalus | 300 | 200 |
| Clarias | 300 | 60 |
| Anabas | 250 | 20 |
| Tilaphia | 100 | 20 |
| Misc. fish | 200 | 50 |
| | Total: | 6,350 |

The harvest shows that Trichogaster adapted and propagated well, but Tilapia did not; many predators have entered, probably during the rainy season, a condition extremely difficult to control, and an annual production in the order of 500 kg/ha has been achieved, which is a very high figure for a converted swamp.

## List of Swamps of the Northeast Stocked with Fish

| Swamps | | | Fish stocked | | |
|---|---|---|---|---|---|
| Name | Area ha | Locality | Kind | Size cm | Number |
| Nong Harn | 7,500 | Sakol Nakorn | Salid | 8-16 | 4,800 |
| " Khao | 10 | " " | (Salid | 14-18 | 240 |
| | | | (Tilapia | 14-16 | 200 |
| " Bong | -½ | " " | " | " | 150 |
| " Ku | 3 | " " | " | " | 72 |
| " Sim | -½ | " " | " | " | 25 |
| " Luang | 20 | " " | " | " | 150 |
| " Pai | 1 | " " | ( " | " | 100 |
| | | | (Tilapia | 6-10 | 100 |
| " Tom | 220 | " " | " | " | 300 |
| | | | (Salid | 10-14 | 50 |
| " Pla | 20 | " " | Tilapia | 7-10 | 20 |
| " Edon | 1 | " " | Salid | 14-18 | 20 |
| " Doak | 75 | " " | Tilapia | 10-15 | 20 |
| " Pucy | 9 | " " | " | " | 50 |
| " Pang Hor | 560 | " " | Tilapia | 3-5 | 3,000 |
| " Mee Chai | 20 | " " | Salid | 12-15 | 25 |
| " Yart | 500 | Nakorn Panom | " | 14-18 | 600 |
| Bung Mor | 20 | " " | ( " | " | 25 |
| | | | (Tilapia | 9-10 | 25 |
| Nong Kon-kwang | 40 | Udon | Salid | 14-18 | 22 |
| " Ang | 4 | " | " | " | 100 |
| " Koon | 2 | " | " | " | 106 |
| " Edun | 15 | " | " | " | 25 |
| " Mek | 100 | " | " | " | 55 |
| " Kang Fai Yai | 15 | " | " | " | 50 |
| " Sao Lao | 25 | " | " | " | 25 |
| 23 Swamps | 9,101 hectares | | | | |

1. Pla salid (Trichogaster pectoralis) have adapted themselves very well to the conditions of swamps; they have now spread to nearby waters, and are frequently caught. This fish is well liked by the people.

2. Tilapia below 6 cm. in length when stocked in swamps are quickly eaten by predators. Those above 8 cm. adapt well to the new environment and grow quickly, but the young produced have little chance of surviving.

ii. The irrigation tanks

The Government has planned construction of about 120 irrigation tanks to supply water to the vast dry area of crop land of the Northeastern Region. More than 60 tanks have already been completed, ranging from 100 to 2,500 hectares in area, 1 to 10 meters in depth. Counting only the area of those constructed, there are already more than 25,000 hectares of newly created waters in which fish production may be developed.

Large natural land depressions are connected to tanks by constructing strong dams across the gaps. In the recently completed tanks the water is turbid, with high acidity and poor plankton growth. Tanks more than one year old usually have clearer water with lower acidity and higher plankton growth. At the same time, a luxurious growth of submerged plants has started which, judging from experience, will rapidly make the water shallow, if allowed to grow unchecked.

A scheme for stocking the tanks with plant feeders such as Puntius, giant gouramy and other suitable species, and fast-growing and self-propagating fish like Trichogaster, Helostoma and Tilapia has been started for a double purpose: (1) to convert the existing raw material into fish; and (2) to assist in controlling excessive growth of aquatic plants.

Up to the present, 18 tanks (about 9,500 ha.) have been stocked with Trichogaster and Tilapia. Trichogaster has adapted well and grows and reproduces rapidly. Tilapia has not yet shown signs of getting really established. Judging from the conditions in the tanks, a conservative estimate of their fish production would be not less than 50 kg/ha/annum, or a total of 1,250,000 kg. per year for all the completed tanks.

At present all the fry and fingerlings are supplied by the fisheries stations. Later, if necessary, small ponds will be constructed nearby the tanks for breeding and rearing fry and fingerlings.

Activities to reduce the number of predators are to be intensified, and a practical scheme, under which the people would fish the tanks without damaging the construction, is being considered by officers of the Departments of Fisheries and Irrigation.

## List of Irrigation Tanks Stocked with Fish

| Irrigation tanks | | | Fish stocked | | |
|---|---|---|---|---|---|
| Name | Area ha | Locality | Kind | Size cm | Number |
| Sok Nam Kao | 280 | Udon | Salid | 14-18 | 230 |
| | | | Tilapia | 5-8 | 1000 |
| Nong Ta Kai | 280 | " | Salid | 8-12 | 304 |
| | | | Tilapia | 5-8 | 8500 |
| Nong Sam rong | 500 | " | Tilapia | 5-8 | 600 |
| Huey nam tieng | 110 | " | " | " | 900 |
| Nong Bor | 300 | " | Salid | 12-15 | 200 |
| | | | Tilapia | 4-8 | 1000 |
| Nong Song Hong | 250 | Nong Khai | Tilapia | 4-8 | 1000 |
| Pu Kratae | 100 | Nakorn Panom | Salid | 8-14 | 225 |
| | | | Tilapia | 5-9 | 7100 |
| Nong Yart | 2500 | " " | Tilapia | 4-8 | 1000 |
| | | | Salid | 12-15 | 200 |
| Chieng Yuen | 250 | " " | Tilapia | 4-8 | 10000 |
| | | | Salid | 12-15 | 200 |
| Huey Pong | 1000 | Sakol Nakorn | Tilapia | 4-8 | 13000 |
| | | | Salid | 12-15 | 200 |
| Huey Siew | 600 | Korn Khaen | Tilapia | 4-8 | 800 |
| Huey Yai | 200 | " " | " | " | 800 |
| Huey Yang | 400 | " " | " | " | 1000 |
| Kaeng Luengchan | 900 | Mahasarakam | " | " | 1000 |
| Nong Boa | 650 | " | " | " | 1000 |
| Nong Chae Vae | 500 | " | " | " | 1000 |
| Huey Vangdang | 300 | Ubol | " | " | 1000 |
| Setserani | 350 | " | " | " | 1200 |
| 18 tanks | 9,470 hectares | | | | |

Note: 1) Pla salid (Trichogaster Pectoralis) adapted well to the condition of the tanks; it grows and reproduces quickly.

2) Tilapia grows rapidly in tanks, but fish below 6 cm. are easy prey for predators.

c) Improving brush pile fishing along rivers and canals

One of the traditional, effective methods of fishing the rivers, canals and streams, is to set up brush piles along the side of the waters. These are usually made by planting branches of dead trees and bamboos which provide a shelter for small fish. The presence of the small fish in turn attracts larger predatory fish. When it is thought that a sufficient number of fish have gathered, the pile is surrounded by a wall net, the branches removed and fish caught.

The living Ipomoea bush has been used in place of the dead branches to improve the efficiency of the brush piles. The weeds along the edge of the water are removed and Ipomoea planted, held in place by a few bamboo poles. Ipomoea provides good food for the forage fish, as well as shelter. It is also favored as a table vegetable by farmers, and its coarser parts are used as fodder for pigs and chickens. Practically every family living along the banks of canals and streams, especially those around Wat Tha-Kleong, has an Ipomoea bush, many of which have developed into elaborate floating water gardens.

2. Stocking fish in confined waters

a) Idle ponds

It has been roughly estimated that there are not less than 200,000 ponds in Thailand (total area about 3,500 ha.), most of which are suitable for conversion for stocking and culture of fish. Many of the ponds are a result of digging for construction purposes, and range from about 100 square meters to about 1 hectare, and from $\frac{1}{2}$ to 3 meters in depth. They are usually densely covered with aquatic plants such as water hyacinth, lotus, water lilies and duckweeds. The common kinds of fish present are snakehead, catfish, climbing perch and some small forage fish, which are caught with rod and line, plunge baskets, spears, or by hand when the water is very shallow. The sources of water supply are generally rain or nearby canals and the depth of water therefore varies greatly in accordance with the rainfall. Most of these ponds have a high potential fish production, but very few, if any, have been developed.

The steps taken to improve the conditions of these ponds are: (1) strengthening the bunds to prevent overflooding; (2) screening the inlets and outlets with a fine bamboo fence, or galvanized chicken fence, to prevent escape of fish and entry of predators; (3) removal of weeds and predators.

Fish used for stocking the ponds are Tilapia, common carp, Sepat Siam, river catfish (Pangasius) and giant gourami. Most of the fry and fingerlings are supplied by the government fisheries stations. Stocking with a single species is the usual practice, although sometimes more than one kind is used.

Up to now about 100,000 ponds (about 2,000 ha.) have been improved and stocked with fish. In ponds that have been efficiently improved, the fish grow well and, in the case of Tilapia, reproduce rapidly. In ponds which have been carelessly improved and where the predators were not effectively removed, a large percentage of the material stocked was soon eaten up, and, in all such cases, even Tilapia failed to become

established. The average annual production of fish from these converted ponds has been estimated at about 500 kg/ha. In many cases simple stocking operations with Tilapia have led to the more carefully controlled culture of carps and gouramy.

b) Water ditches of vegetable and fruit gardens

The common practice for farmers and fruit growers to dig water ditches between and around rows of vegetable beds or fruit trees has been observed throughout the country. The ditches are about $1\frac{1}{2}$ to $2\frac{1}{2}$ meters wide and $\frac{1}{2}$ to 1 meter deep. Although the ditches are primarily for irrigation, they provide environment suitable for fish.

Most of the ditches are able to retain water to a depth of about $\frac{1}{2}$ meter for a period of 7 to 8 months, and some of them can retain water even throughout the year.

Ditches on vegetable farms are unshaded but the water is constantly being disturbed. On the other hand, ditches on fruit farms are quite densely shaded by trees but the water is not often disturbed. In both cases the source of supply of water is rain and nearby canals. The fish present are mainly of predatory species.

Before stocking the ditches with fish, two principal improvements are carried out: (1) water inlets and outlets are screened to prevent escape of fish and entry of predators; (2) predators are caught by simple hand gear. In some cases, the ditches need to be deepened and the bunds strengthened.

The kinds of fish used for stocking are Tilapia, common carp and Sepat Siam or pla salid (Trichogaster pectoralis) either singly or in combination.

Results have shown that efficiently improved ditches are able to produce almost the same amount of fish, per unit water surface area, as the converted ponds.

There are roughly about 5,000 hectares of these ditches in Thailand, of which only about 100 hectares have so far been improved and stocked with fish. Difficulties in the control of predators and water level are the chief factors limiting progress.

c) Rice fields

From time immemorial, farmers of Thailand have derived considerable quantities of fish from their rice fields. The fish enter the paddy fields, with the flood, to feed and, when the water recedes, become stranded and are caught. Although a large variety of fish must have entered the fields, the fish eventually caught consist chiefly of predatory species.

Rice fields of Thailand may roughly be grouped into three types: (1) the wet land type in the hilly region of Chiengmai and other Northern provinces; (2) the floating rice type in the low central plain, and (3) the dry land type in the rest of the country.

Rice fields of the wet land type are situated on sloping hillsides and valleys, and depend upon both rain and streams for supply of water. Floating rice fields are completely flooded for the entire period of rice growing. The dry land fields depend upon both rain and flood for supply of water. They are dried during the dry season. Rice fields of type (1) are very suitable for improvement for stocking fish, those of type (2) are unsuitable, and those of type (3) may be improved for the purpose.

It has been estimated that approximately 200,000 hectares of rice fields and other crop land are suitable for fish stocking but use of them has been started only on an experimental scale. The kind of fish being stocked are common carp, Sepat Siam, Tilapia and kissing gouramy.

The steps taken to stock the rice fields with fish are as follows:-

a) strengthening and increasing the height of the field's banks, to prevent flooding;
b) screening the inlet and outlet with fine bamboo screen or fence to prevent escape of fish and entry of predators;
c) constructing fish trenches along the edge or across the center of the fields. The trenches are about 1 meter wide and 1/3 meter deep; They serve as a retreat for fish when the water is low and as an effective way to harvest the fish without disturbing the rice;
d) applying organic fertilizers, but using about $\frac{1}{4}$ more than the usual quantity;
e) stocking the fish about seven days after the transplantation of paddy plants, at the rate of approximately 5,000 fish per hectare of field.

Results of stocking do not show harmful effects on the rice plant; in fact, in some cases, the production of rice has been slightly increased. The average production of fish is about 100 kg/ha.

Difficulties in the control of water level and predators are the main problems.

3. Improving hatchery techniques

a) Spawning of fish

i) Common carp (Cyprinus carpio)

Mature males and females of good quality are selected from the stock reared in the breeding ponds and are segregated in two wooden tanks for two to three days. Meanwhile, the spawning pond (about 4 x 8 meters in size and 1 meter in depth) is drained, cleaned and refilled with clean, fresh canal water.

Objects to which spawn may attach (Ceratophyllum, Hydrilla, fibers of palms, fibers of Nepa flower and even water hyacinth with long roots, have been used with good result) are set at the center of the pond, with bamboo poles to keep them barely submerged.

The conditioned male and female fish are introduced into the spawning pond late in the afternoon, and spawning usually starts during the early hours of the next morning. Usually only two females and four males are used in such a small spawning pond. The ratio between sexes is approximately 1:1 by weight. Females 2 to 5, and males 1 to 4 years old, are the best age for spawning under Thai conditions.

By keeping about 100 pairs of good breeders in the stock ponds, successful spawning operations may be carried out any day in the year, and Thailand fisheries stations are now capable of producing many more common carp fry and fingerlings than are in demand.

ii) Tilapia (Tilapia mossambica)

Spawning of Tilapia requires no special technique, but an essential condition is that the spawning pond must be absolutely free from predators. Experience has shown that even such seemingly harmless small fish as pla kadi (Trichogaster trichopterus) are very fond of eating the eggs and newly hatched larvae of Tilapia.

Mud ponds about 10 x 20 meters and ½ to 3/4 meter deep are convenient for the purpose. Whenever possible the pond should be completely drained and all fish removed. Where draining is difficult or uneconomical, local derris roots can be used to kill the fish present. The pond must then be heavily fertilized with both stable and green manure. About ten days later, 40 to 50 pairs of matured Tilapia may be released in it. Spawning starts within two weeks, and about 8,000 to 10,000 Tilapia fingerlings can be harvested from the pond every two months.

iii) Sepat-Siam or pla salid (Trichogaster pectoralis)

The spawning technique developed by Mr. Boon Indrambarya, Director-General of the Thai Fisheries Department, has been employed with slight modification.

Matured parent fish are selected from the stock, and the males and females are kept segregated in two wooden tanks for three to four days. For small-scale spawning, wooden tanks of about 1 x 2 meters and 3/4 meters deep are used. The tanks are drained, cleaned and refilled with freshly filtered canal or pond water. Healthy Ipomoea plants with clean roots are placed in them, occupying about half of the tank surface, and shaded from above with loosely thatched palm leaves. Two pairs of the conditioned mature fish are then put into the tank. The fish will start

building bubble nests in three to five days, and soon start spawing. The parent fish are left in the tank to protect and fan the eggs until they hatch.

For large-scale spawning, mud ponds about 10 to 20 meters and ½ meter deep are used. They are drained, the predators and other fish removed and excess aquatic plants eliminated. They are then fertilized with stable manure and refilled with clean, fresh canal water. Ipomoea bushes are planted at the four corners and are partially shaded in the manner already described. About 50 pairs of matured fish, which have been segregated in tanks for a few days, are then introduced, and bubble nest building and spawning will take place about a week afterwards.

iv) Kissing gouramy (Helostoma temmincki)

The spawning technique used for this fish is very similar to that for the Sepat Siam, except that instead of providing Ipomoea as a site for building bubble nests, chopped banana stems are floated on the water to prevent the eggs from drifting to the edges of the tank or pond and being spoiled.

Spawning takes place early in the morning of the day after the breeders are introduced. The eggs float on the surface of the water and will hatch within 24 hours.

v) Giant gouramy (osphronemus goramy)

Mud ponds about 100 square meters and 1 meter deep are used. They are completely drained and refilled with clean, fresh canal water. Three to four nest frames, made of bamboo, are set at suitable places around the edge of the pond, and nest building material, such as Ipomoea branches, stalks of grass and aquatic plants, are scattered around the frames. Three to four pairs of mature fish are then introduced.

Within about a week the fish will start using the nest frames and nest-building material. The actual spawning act cannot easily be observed, but the appearance of oil globules above the nest, especially when it is slightly disturbed, indicates that eggs have already been laid.

The nest with its eggs is carefully removed from the pond, and placed in a big container of clean, fresh pond water. The nest is gently opened and the eggs are allowed to float. They are then carefully transferred with small bowls to hatching tanks or earthen hatching jars.

vi) Puntius carp (Puntius javanicus)

The popular Indonesian technique has been introduced. The spawning operation with this fish has not been entirely successful at the Bangkhen Fisheries Station, where the water is rather turbid and is supplied entirely by pumping from nearby canals. But it

has been successful at the Kwan Payao Fisheries Station, where there is a continuous flow of clean water to the ponds.

b) Collecting fry and fingerlings from open waters

The two popularly cultured species of river catfish, pla sawai (Pangasius sutchi) and pla topo (Pangasius larnaudii) do not reproduce under cultivation. their young are collected by seines, cast nets and scoop nets from water locks and canals. The fingerlings collected are usually of quite advanced age, having the sharp pectoral spines already well developed, thus being liable to inflict wounds on one another and cause high mortality. It is therefore desirable to design special collecting nets.

The fry collecting net is made of ramie cloth, or similar material, and is based on the design of the Chinese fry collecting net. Each net consists of two wings and a central tapering bag. The end of the bag is made of thicker cloth and is opened on its upper surface, which is supported by a floating bamboo frame, in such a way that the opening, which is about 40 x 30 cm., is always maintained a few inches above the surface of the water while the rest of the bag is kept submerged.

The net is set with long bamboo poles at the side of the river, where there is a gentle current. The fry and young fingerlings carried by the current into the net are concentrated at the end of the bag, the catch chamber which, being made of thicker cloth, is able to reduce the pressure of the water current, thus protecting the fragile fry from being crushed. The fry are scooped out with a bowl through the suspended opening without disturbing other parts of the net, and are temporarily kept in a storage net which is floated in water by means of a bamboo frame.

This net has been found to be useful for collecting catfish and chanos fry and those of several species of river fish.

Fry collecting is to be intensified to build up an efficient fry industry to serve the rapidly developing fish stocking and culture operations.

c) Rearing fry and fingerlings

The old practice of rearing fry and fingerlings in wooden tanks and small ponds, by feeding them with food such as egg yolk, liver and flour, was found to be impractical and uneconomical. The foods are expensive and young fry easily overfeed and die.

The answer to this problem is to improve the preparation and management of nursery ponds to increase production of natural food.

Shallow ponds with good fertile soil are selected for this purpose. They are completely drained and all existing animals eliminated. An organic fertilizer - a mixture of animal manure, rice bran and some peanut cake (residue of peanut oil extraction) - is applied to the bottom of the

pond in a thin layer. Just enough water is let in daily to cover the fertilizer. After about one week the pond is partially dried by evaporation (not drained) and a second application of organic fertilizer is made, and again enough water is let in daily to maintain a depth of about 10 cm. After about a week, when a thick coat of green algae has developed, water is let in to a depth of about 30 to 40 cm., and the pond is then ready for the fry. A nursery pond thus prepared is able to produce and maintain for a considerable time a rich supply of excellent natural food for the fry such as diatoms, phytoplankton, blue-green algae, etc. They fry grow quickly on these rich foods because they do not overfeed. The mortality rate is low. This method has been successful in rearing all kinds of fry.

d) Transportation of stocking material

Methods used for transporting stocking material vary according to the quantity of fish and time or distance involved.

Ordinary water carriers, tin containers, buckets, and fry tins are used for transport of small quantities over short distances. The containers are either kept open or have a perforated cover.

Special fry-carrying trucks equipped with live fish tank, pump and continuous water circulating system, are used for transport of large quantities over longer distances. Each truck can carry about 20,000 fingerlings of 3 to 5 cm. size on a journey lasting 18 to 24 hours. The mortality rate is less than 5 percent.

Hermetically sealed tins or cans, provided with oxygen, such as those used in Hong Kong and Indonesia, have also been employed in the case of long-distance transport by air or by train.

Difficulties in obtaining airtight tins has led to the use of plastic bags. These are cheap, light, easy to handle and, as they are transparent, inspection is simple but they are not strong enough for rough handling and may be punctured easily. The practice evolved is as follows:

i) place the plastic bag inside a bamboo basket, or a cardboard box;
ii) fill the bag about 1/3 with clean, freshly filtered pond water;
iii) put in the fish (which have been given no food for 12 to 24 hours;)
iv) force out the air inside the bag by collapsing it;
v) inflate the bag fully with oxygen from a cylinder;
vi) tie the opening of the bag securely and complete the packing.

4. Improving culture methods

Fish culture practice in its true sense has only recently been introduced to Thailand, although for a great many years the people released fish into ponds and sanctuaries of temples mainly for religious purposes. The culture of fish in ponds for the production of food was only started about 40 years ago by Chinese immigrants, who brought with them some common carp (Cyprinus carpio). Soon afterwards, fry and fingerlings of other Chinese carps were imported, but the only fish culture was by a few Chinese, on a small scale, and confined to the Bangkok area.

The numerous small ponds constructed and maintained by the farmers in various parts of the country, especially along the rivers and canals of the Central Plain, are trapping ponds. These, together with the numerous idle ponds of private individuals and of farm villages, form the basis for a promising fish culture development, in which the progress made may be described as follows:

a) Preparation and management of ponds

The principal problems involved are:

i) control of water level;
ii) control of weeds and predators;
iii) maintenance of supply of natural food.

Flooding of ponds during the rainy season is prevented by strengthening and increasing the height of the banks. Soil needed for such purpose is dug from the bottom of the pond which, by being so deepened, is enabled to retain more water during the dry season. The Chinese "dragon wheel" water pump, which may be operated manually or by a motor, is used. The water inlets and outlets are always carefully screened with bamboo or galvanized wire fences, and sluice gates, made of strong wood, are often installed in big ponds. Unwanted plants are removed by hand and piled along the bank to decay into fertilizer for the pond.

Local derris roots are effective for killing predators. One kilogram of the root is sufficient for treating 100 cubic meters of water. The roots are first pounded, then soaked in a bucket of water for five to ten minutes. While soaking, the broken roots are rubbed vigorously between the hands to press out as much liquid as possible. The water in the bucket soon becomes a milky white solution which is drained into another container and is ready for use. The residue is again soaked with pond water and the process repeated several times until no more liquid can be pressed out. The white liquid is thrown by the bowlful into the pond, as evenly as possible, so that the entire water surface is treated. The liquid will sink and diffuse rapidly. Carps are affected within ten minutes. Air breathers and other tough fish expire in about 20 to 30 minutes. Fish affected by the poison show signs of great distress, swimming vigorously but aimlessly on or near the surface of the water, and can easily be caught with hand nets. Those caught during the early stage of poisoning may be revived by placing them in fresh, clean pond water.

Fish affected or killed by the derris solution, if thoroughly washed in clean water, can be used for human consumption without danger. The poisonous effect of derris solution, when exposed to air, disappears gradually. It takes from five to seven days for the treated pond water to be safe again for fish life, but the usual practice is to allow about ten days to elapse before stocking fish.

In many parts of Thailand, especially in the northeast, the pond water is quite high in acidity and turbidity. An application of lime is necessary to reduce the acidity, but in places where lime is unavailable, or too

expensive to use, burnt rice husk serves as a good substitute. Repeated application of stable manure and planting of Iponoea have in many cases helped to clear the water.

Fish ponds with compost piles set at the corners, an Iponoea bush planted along the edges, and a pig sty and chicken coops established on the banks, have been proved to be very productive and economical, and are suitable for the farm villages. The excrement from the pigs and chickens is washed into the pond every morning to provide, together with the compost piles, a constant supply of fertilizer and promote production of natural fish food. Iponoea is a fast-growing aquatic plant, a good food for some of the fish, useful as fodder for pigs and chickens and a popular table green among the local people.

The application, after draining, of animal manure and rice bran to the pond, followed by exposure to the sun under shallow water, gives rise to a rich growth of algae, diatoms and other small organisms, all important fish food.

The culture of Wolffia, in shaded ponds, using rice straw and stable manure as fertilizer, has been successful in providing food for young fish.

b) Stocking, care, feeding and harvesting of fish

The kinds of fish which have been successfully cultured in Thai waters are as follows:-

| Group | Common name | | Scientific name |
|---|---|---|---|
| | Thai | English | |
| 1 | Pla salid<br>Pla mortan<br>Pla rat | Sepat Siam<br>Kissing gourany<br>Giant gouramy | Trichogaster pectoralis<br>Helostoma temmincki<br>Osphronemus gorany |
| 2 | Pla sawai<br>Pla tepo<br>Pla kapong<br>Pla nuanchan | River catfish<br>River catfish<br>Sea bass<br>Milk fish | Pangasius sutchi ?<br>Pangasius larnaudii<br>Lates calcarifer<br>Chanos chanos |
| 3 | Pla nai<br>Pla morted | Common carp<br>Tilapia | Cyprinus carpio<br>Tilapia mossambica |
| 4 | Pla Chao-Hue<br>Pla Lin-Hue<br>Pla Soongh-Hue | Grass carp<br>Silver carp<br>Big-head carp | Ctenopharyngodon idellus<br>Hypophthalmichthys molitrix<br>Aristichthys nobili |

Fish of group (1) are native species which can reproduce under cultivation; those of group (2) are native fish which are, at present, unable to spawn in ponds and their fry and fingerlings are collected from natural habitats; group (3) consists of introduced fish able to reproduce under cultivation in Thai waters; and group (4) includes the introduced species which cannot reproduce under cultivation and their fry and fingerlings have to be imported for stocking every year.

Over 600,000 fingerlings of Chinese carps were imported during 1954. The popular Chinese method for cultivating these fish, including the number and ratio for mixed stocking, has been adopted with some slight modifications to suit local conditions. Since there is no cold winter in Thailand, the fish can grow throughout the year. It is therefore possible to have three crops of fish in two years. Mixed stocking of two different ages of fish - young fish and fingerling - has been done with profit in rich ponds. In a pond stocked with two different ages of fish in the early spring, the young fish grow to marketable size by the middle of the year, and the fingerlings, by the end of the year, become fish of marketable size.

Common carp and the river catfish can be cultivated either singly or in combination with the Chinese carps.

Sepat Siam and kissing gouramy are mostly cultivated alone, but may also be combined with other species.

When cultivated singly, the stocking rate for an average pond of 1 hectare is as follows:

| Name of fish | Number per hectare |
|---|---|
| Common carp | 3 000 |
| River catfish | 2 000 |
| Sepat Siam | 10 000 |
| Kissing gouramy | 10 000 |
| Giant gouramy | 1 500 |
| Chinese carps | 2 000 |

The following combination, ratio and intensity of stocking have been suggested for experiment:

| Group | Name of fish | Rate of stocking per hectare | | | | | |
|---|---|---|---|---|---|---|---|
| | | Average pond | | Fertile pond | | Poor pond | |
| | | Number | Ratio | Number | Ratio | Number | Ratio |
| 1 | Grass carp | 600 | 1 | 600 | 1 | 400 | 1 |
| | Common carp | 1 200 | 2 | 1 200 | 2 | 800 | 2 |
| | Sepat Siam | 1 800 | 3 | 3 000 | 5 | 1 200 | 3 |
| | Kissing gouramy | 1 800 | 3 | 3 000 | 5 | 1 200 | 3 |
| 2 | Common carp | 1 200 | 2 | 1 200 | 2 | 800 | 2 |
| | Sepat Siam | 1 800 | 3 | 3 600 | 6 | 1 200 | 3 |
| | Kissing gouramy | 1 800 | 3 | 3 600 | 6 | 1 200 | 3 |
| | Puntius carp | 1 800 | 3 | 1 800 | 3 | 800 | 2 |
| 3 | Pangasius | 600 | 2 | 600 | 2 | 400 | 4 |
| | Catlacarpio | 600 | 2 | 900 | 3 | 400 | 4 |
| | Cirrhinus | 900 | 3 | 1 200 | 4 | 400 | 4 |
| | Cyclocheilichthys | 300 | 1 | 300 | 1 | 100 | 1 |
| | Puntius | 1 200 | 4 | 1 200 | 4 | 800 | 8 |

In the stocking and culture of Tilapia the problem of over-population has in many cases been solved by:

i) constant removal of young, and
ii) by stocking a few snakeheads, about 50 to 100 per hectare, when the pond is already well populated with Tilapia.

A simple stocking schedule adopted by the Thai farmers includes:

i) pond properly prepared and fertilized in January;
ii) stocking with fingerlings of about one month old (these fingerlings will start reproducing by May and by July, when the monsoon starts, the pond will be already well populated with Tilapia);
iii) allow snakehead fish to come in during heavy rains, and
iv) harvest both Tilapia and snakeheads at the end of the year.

In Thailand, as in other tropical countries, one of the chief causes of fish mortality is asphyxia, which occurs, especially in fertile ponds with a dense fish population, during very hot weather in which there is sudden heavy cold rain (or hail), or after a period of hot, quiet and cloudy weather, without rain or breeze. In the former instance, asphyxia may occur during any time of the day, usually when there is a complete turnover of the pond water. Even the bottom mud is liable to be disturbed and the pond water becomes smelly and almost black in color. In the second instance, asphyxia occurs early in the morning before sunrise. In both cases prompt action in the use of efficient mechanical aeration and mixing the

water by pumping and spraying, or beating the water with bamboo branches or banana leaves, may save the fish.

Both kerosene and peanut oil soap emulsion have been used to control aquatic insects in nursery ponds, while the popular salt water bath method has been used to control ectoparasites.

Rice bran, broken rice, residues from vegetable oil extraction, soybean milk and curds, tapioca, and kitchen waste have been used as supplementary food for the fish. Dead baby chicks from the poultry hatcheries are excellent food for the river catfish, Pangasius larnaudii. Cooked broken rice mixed with rice bran and chopped Ipomoea stem, young water hyacinth shoots or tender aquatic plants, make a suitable food for all the species of cultivated fish. Leaves of all kinds of beans, peas and other legumes, tender grasses, and duckweeds, are used to feed grass carp, giant gouramy, Puntius and Tilapia. Leaves and other plant material are placed inside a floating feeding ring made of four long bamboo rods. Cooked rice, residues of agricultural products and kitchen waste, are put in feeding trays made of wood. White ants are also extensively used as fish food in places near the forest. The nests, with the white ants inside, are chopped into bits on the feeding stand while fish gather round, waiting to swallow the insects as soon as they drop into the water.

Harvesting is done the whole year round, starting as soon as the fish have grown to marketable size. However, many Chinese carp culturists make better profits by timing their harvest to meet the demand for fish during important festivals.

Cast nets, lift nets and scoop nets are used for catching fish in small ponds or when cropping is limited. Seine nets are used in big ponds, or for complete harvesting.

Carp fetch more alive than dead because the flesh deteriorates very rapidly after death. It is, therefore, in the interests of the fish agents and sellers to take good care of the fish and keep them alive in transit and at the retail markets until sold to the consumers. Shallow containers are used, with just enough fresh pond water to cover the back of the fish for transporting Chinese and common carp from ponds to the market. The fish are kept alive at the retail market by maintaining a simple continuous circulation of clean, fresh water through the containers.

o) Finding suitable local species of fish for stocking and culture

Among the numerous inland water fish of Thailand, some possess qualities which make them suitable for development as good pond fish. The steps taken to find such fish are as follows:

i) Those already known to be suitable for culture:

Puntius javanicus, Puntius schwanenfeldii, Osteochilus hasseltii,

and Chanos chanos are the four local species which have already been generally cultivated in Indonesia. Established methods for their propagation and culture have been introduced for trial and adoption in Thailand.

ii) Selecting for experiment, fish closely related to, or having similar food habits and qualities of, those which have been cultivated in other countries:

Catlacarpio siamensis, Cirrhina microlepis, Cyclochcilichthys enoplos, Pristolepis fasciatus and Mugil sp. have been selected for their resemblance to such well-known pond fish as Catla catla and Cirrhina mrigala of India, Cirrhina molitorella and Mylopharyngodon piceus of China and Carassius auratus and Mugil cephalus, respectively.

iii) Selecting, for experiment, non-carnivorous fish which can grow to a fair size, and possess a good food quality:

Probarbus jullieni (pla essok), Tor tembroides (pla wien) and Datnioides microlepis have been selected for this purpose.

The fish for experiments (ii) and (iii) are selected on the basis of their qualities and feeding habits as given by Dr. Hugh M. Smith in his book The Freshwater Fishes of Siam and in other Siamese literature. The information was checked by actually tasting the fish and by examining their stomach contents. Young fish finally selected were collected from their natural waters and stocked in ponds for observation.

Up to the present, three good species, besides those known to be cultivable, have been found to be suitable for stocking and culture:

(i) Catlacarpio siamensis (Pla Kaho)

This is primarily a river fish, but it has occasionally entered ponds and canals. It is a phytoplankton feeder when young, but develops into a zooplankton and soft algae eater when big. It is one of the largest species in the world of Cyprinoid fish and can grow to 3 meters in length weighing over 50 kgs. This fish will be useful for culture in ponds as well as for stocking in swamps and irrigation tanks. It adapts well to the conditions and grows rather rapidly.

(ii) Cirrhina microlepis (Pla nuan chan)

This fish is essentially a plankton and algae eater but it also takes small insects and worms. It can attain a large size, adapts well and grows rapidly under pond conditions, and has flesh of excellent quality.

(iii) Cyclocheilichthys enoplos (Pla takok)

This fish is of excellent eating quality, and adapts well to pond, swamp and tank conditions where it can grow to more than $\frac{1}{2}$ meter in length. It is primarily a snail and clam eater, but also takes insects and worms.

d) Introduction of exotic species

In promoting the introduction of an exotic species in Thailand, it is necessary to look for a kind of fish which has not only good food quality, grows and reproduces rapidly, and has no harmful effect on the local fish, but can also be handled easily and possesses habits that will attract and develop the interest of the people. Tilapia mossambica has been selected for introduction to Thailand waters because it has these qualities.

All the imported specimens were kept under observation in protected ponds (some uncleaned ponds, and some cleaned, with the predators eliminated), and in some protected sections of water ditches. It was not until evidence showed that (1) the local snakehead fish and other predators are effective enough to keep Tilapia under control; and (2) that Tilapia is welcomed by the people as food, that this exotic fish was produced and distributed for stocking and culture. Tilapia mossambica has served remarkably well for this purpose and has, within a comparatively short period, created deep interest among the people and laid a good foundation for the rapid development of the project.

C. Popularizing Stocking and Culture of Fish

The Thai Fisheries Department has, for the past 20 years, made several attempts to promote fish culture practices among the Thai people. Unfortunately, despite the importance and value of these practices, all such attempts have failed to achieve many results because the people have not been sufficiently interested in the matter.

In implementing the present inland fisheries development project, all possible ways and means have been used to arouse interest among the people and to induce them to accept and adopt the new enterprise.

1. Public lectures

Public lectures, radio broadcasts and news releases by fisheries officers, prominent government authorities and the writer have been used to spread knowledge of fish stocking and culture. Popular lectures on fish culture have been given at schools, clubs and associations, and have created interest among the audience and gained considerable support among the public.

2. Public exhibitions

Instead of the usual display of a few kinds of aquarium fish at temple fairs, models, diagrams, charts and specimens to demonstrate the various phases of fish culture, have been exhibited. Thousands of people have been attracted and extension pamphlets and fish-stocking material were given to those interested. Similar exhibits were organized at the annual Science Conference, the National Day Fair, the Constitution Fair, and annual Agricultural Fair, and other important national, public and religious functions. Due to these activities, and to the action of progressive farmers who attended the fairs, many villages have developed fish stocking and culture operations.

3. Demonstration centers

Demonstration fish culture centers were set up in the various provinces and districts. The centers were organized in co-operation with the local authorities. The Fisheries Department supplied technical personnel, equipment, material, and part of the expenses involved, to get the centers started, while the local authorities were responsible for their management and maintenance.

Suitable idle ponds were selected for conversion into fish ponds. Farmers and interested civilians were invited to take part in cleaning the pond, removing the predators and weeds, applying fertilizers, and stocking and taking care of the fish afterwards. Some ponds were prepared as storage ponds for stocking material from the Fisheries Department for distribution to the people. Later, local ponds were able to produce enough fish to meet the local demand.

Demonstration centers were also set up in schools, barracks, and even in prisons, so that many students, soldiers and prisoners have learned a useful vocation.

4. Extension pamphlets

A pamphlet on "How to culture Tilapia" was prepared by the writer, translated into Thai by Mr. Ariya (Head, Bangkhen Fisheries Station), published jointly by the Thai Ministry of Agriculture, FAO and the U.S. Foreign Operations Administration and financed by the latter administration. This pamphlet was so popular that 200,000 copies of the first edition were soon distributed, and a second printing of 110,000 copies was issued to meet the demand.

With the advice of the writer, articles on "Milkfish Culture" and "Kissing Gouramy Culture" have been prepared by Thai Fisheries officers for publication in the Thai Fisheries News. They may be printed as separate extension pamphlets in the future. Similarly, extension pamphlets on "Common Carp Culture," "Siamese Catfish Culture," "Sepat Siam Culture," "Giant Gouramy Culture," "Mullet Culture," and "Chinese Carp Culture" are being produced.

A very simple, illustrated article on "How to Culture Fish" has also been issued for the schoolchildren and members of 4-H clubs.

5. Teaching farmers directly

An ambitious scheme to teach practical fish stocking work to 10,000 village chiefs and farmers has been initiated.

Each session takes only one day to complete, covering important topics such as: (1) meaning and aim of fish stocking; (2) preparation of a fish pond; (3) elimination of fish enemies and noxious weeds; (4) application of fertilizers; (5) stocking, feeding, care and harvesting of fish; and (6) fish culture in collaboration with pig and poultry raising and vegetable farming. Half of the day is spent in lecturing (with demonstrations) and the other half in field observation and practice.

Trainees are selected from farmers and village chiefs and are organized into groups of 50 to 80 by local officers. Students are sent to the fisheries stations for training if they live in the neighborhood. If they live in districts far away from the stations, competent officers are sent to conduct the training in their neighborhood. For practical efficiency as well as the psychological effect, most of the lectures, during the sessions held at the Bangkhen Fisheries Station, were given by the writer and translated into Thai by senior Thai fisheries officers.

A movie film was taken by the Visual Education Unit of the army during the training sessions and is now being used for teaching fish culture to the armed forces.

Many farmers not yet selected have requested similar training as well as groups of school teachers, civilians, and even officers of the armed forces. A total of 81 training sessions have been conducted so far, more than 6,500 persons from 75 districts participating. About 50 percent of the trainees have taken up fish stocking as an avvocation.

H.E. the Deputy Premier, Field Marshal Phin (concurrently the Ministry of Agriculture) has taken such a keen interest in this scheme that he was present at more than ten of the training sessions held at the Bangkhen Fisheries Station.

Number of village chiefs, farmers and civilians trained in practical fish stocking and culture.

| Locality of training | No. of sessions | Number of persons trained |
|---|---|---|
| Bangkhen Fisheries Station | 40 | 2 800 |
| Nong-Harn Station | 4 | 250 |
| Maecho Station | 2 | 120 |
| Kwan Payao Station | 5 | 350 |
| Cha Choeng Sao | 10 | 620 |
| Provincial Fisheries Offices | 20 | 2 440 |
| | Total: | 6 580 |

6. Providing direct service to the people

Extension service workers have frequently encountered farmers, especially in a new district or village, who are either reluctant or unable to have their idle ponds converted into fish ponds because they have neither the knowledge nor the tools for such an undertaking. While verbal advice is seldom readily accepted, direct service in assisting them to get their ponds properly converted is always welcome.

Direct help is provided through the field service teams. Each team consists of one extension service officer or a trained foreman and two experienced workers, and is provided with a jeep equipped with a water pump, fish nets and other field tools. The duty of the service team is to assist the owners of idle ponds, free of charge, to remove weeds and predators, screen the water inlets and outlets, strengthen the bunds and help in other activities necessary to convert the idle ponds into proper fish ponds. The initial supply of fry and fingerlings is also frequently delivered by the service team.

At present there are four such teams, each attached to one of the main fisheries stations. Additional teams are now being organized to meet the ever-increasing demand.

7. Extension work through religious observances

Traditional religious observances in which live fish are released as "offerings" in temple and private ponds during wedding anniversaries, birthdays and religious festivals, are still generally performed by the people. The fish used on such occasions are usually small in size but very hardy, such as the "climbing perch" (Anabas), and are either bought from fish dealers or caught in natural waters.

A scheme has been developed for using such occasions to popularise fish stocking and culture without interfering with the ritual. The object is to persuade people to accept Tilapia, Trichogaster, Cyprinus and other pond fish as suitable substitutes for the customary pla mor (Anabas). The scheme has proved successful and has now been adopted extensively.

During last year's annual Songkran Festival, about 20,000 Tilapia fingerlings were distributed to over 200 people for release as "live offerings" in the district of Pra Pradieng. Since then this district has taken up fish culture enthusiastically, and the release of Tilapia, carps and gouramy into the pond at the Royal Summer Palace by Their Majesties the King and Queen during their wedding anniversary aroused the King's interest in the promotion of fish culture.

8. Encouragement from royalty and government authorities

People were encouraged to take up fish stocking and culture by the example of Their Majesties, who converted the old swimming pool at the palace into a fish pond. Their Majesties stocked the pond with some Tilapia, gouramy and a few carps, gave them food and observed them frequently. About three months afterwards, several thousand young Tilapia were produced and, with the King's gracious consent, a special ceremony was arranged at the Bangkhen Fisheries Station for distributing the fish for stocking and culture.

The fish were transported to the fisheries station where they were packed in plastic bags. Several thousand people, including farmers, laborers, schoolteachers, students, civilians, civil officers and soldiers, attended the ceremony which was concluded by Their Majesties giving bags of fish directly to the people. News soon reached every corner of the kingdom and the demand for fry and fingerlings, and technical knowledge for their culture, increased rapidly.

The interest, encouragement and support given by the Premier, the Deputy Premier, the Ministry of Agriculture and other high government officials have been of immense value for the rapid progress of the project. Large sums have been appropriated for the purpose and all provincial and district officers have been instructed to give fish stocking and culture high priority in their activities.

## III. SUMMARY OF RECOMMENDATIONS

### A. General Policy

Fish culture, in its true sense, represents the highest stage of development of restricted bodies of inland waters, requiring highly specialized techniques and skill. Furthermore, since the area suitable for fish culture is rather limited, its potential productivity is small when compared with that of open inland water systems, such as rivers, streams, etc., which are available for immediate increase of fish production with comparatively simple improvements. It is important, therefore, that a long-term development program should be balanced, with equal emphasis on the following fundamental aspects:

(1) better management of the resources of the open water systems - including improvement of conditions for the wild stock, and their full exploitation and use;
(2) stocking with fish that are able to fit into the ecological niches;
(3) development of fish culture proper.

### B. Development Program Proper

#### 1. Better management of inland water resources

a) To improve the existing stock in the open water systems and to evolve a technique for their full exploitation and proper management would require a long-term program. This would call for a team of fisheries officers (including a biologist, technologist and economist) to make detailed surveys and studies of the natural conditions of the open systems; the composition and behavior of the wild stocks; the complex inter-relationship between the members of the stock (especially the relationship between predators and forage fish) and between the stock and the environmental factors; the existing fishing gear and methods and their effects on the fluctuation of the stock; design of new gear and tests of their efficiency and economy, and the possible effects of their use on the stock; and the socio-economic background of the people concerned in the fisheries.

b) Among the species of fish to be studied, the group collectively known as "pla soi" (small cyprinoids such as barbels) should be given priority attention. There are strong indications that "pla soi", apart from being the principal inland fish (in quantity) for man, is the chief source of food for carnivorous fish. Very little is yet known about its biology and habits. Detailed knowledge of this fish would serve as the principal basis for planning proper management of the aquatic resources, especially those of the Central Plain.

c) Improvements of open water systems, such as those initiated (described under IV, B, 1b) should be extended to new localities and

wider areas. It would accelerate progress if fishing gear for catching predators, and tools for removing noxious plants and for constructing simple bunds, could be provided, free, for the people.

d) Experience shows that success in developing swamps and lakes depends primarily on the co-operation from the village people, and the degree of co-operation depends on the profit they can expect. It is, therefore, advisable to assign swamps and lakes, whenever feasible, to people of the nearby villages. The swamps and lakes should be developed, used and maintained on a co-operative basis, under the technical supervision of fisheries officers.

e) There are dense populations of wild stocks in most of the big swamps which have been converted into lakes and declared fish sanctuaries. Large quantities of fish are being wasted. An average of about 10 to 20 kg of fish could be harvested yearly from every hectare of these waters without ill effect on the stock. There should be regulated fishing under the supervision of fisheries officers. Detailed catch statistics should be kept and studied for the purpose of improving methods of management and exploitation.

2. Simple stocking operations

a) Stocking Sepat Siam or pla salid (Trichogaster pectoralis) and Tilapia in swamps, lakes and irrigation tanks should be continued, and fish such as Puntius and gouramy, which are able to help in controlling excessive growth of submerged aquatic plants, should be more extensively used. There should be release of Pangasius, Catlacarpio, and even common carps.

b) Since it has already been shown that pla salid, Tilapia, common carp and kissing gouramy, grow well in rice fields without ill effects on the paddy crop, more of these fish should be cultivated in rice fields. Methods already successfully applied in the promotion of pond culture among village people should be adopted for this purpose.

Meanwhile, apart from trying to obtain more effective control of water level and predators, experiments to find the best combination (pla salid, Tilapia, common carp, and kissing gouramy) and the optimum density for stocking with the various varieties of rice, should be continued and intensified. Most of the experiments should be conducted in the north (at both the Maecho Field Station and the Kwan Payao Station) where most of the Thai rice fields suitable for stocking fish are located.

c) Stocking fish in water ditches of vegetable and fruit farms should be continued. Besides Tilapia, common carp and pla salid should be more extensively used for this purpose.

3. Development of fish culture

a) Proper measures should now be taken to develop existing stocking operations into more effective fish culture. Ponds which are at present

used for simple stocking should be improved so that their conditions may be better controlled. People stocking with Tilapia should be taught pond management and effective control of pond conditions; to practice more effective culture technique, and proper application of fertilizers and supplementary feed, etc. Production of stocking material (common carp, pla salid, kissing gouramy, giant gouramy, Pangasius and other suitable fish) should be increased to provide a supply to meet the increasing demand.

b) Progressive fish farmers should be taught hatchery operations and fish fry rearing and handling operations so that, commercially, the fish culture industry may be taken over by the people. Then government technicians can concentrate on experiments for improving fish culture.

c) These experiments should be directed along the following lines:

i) improvement of breeding stock by repeated selection of breeders and controlled breeding;
ii) improvement of gear and technique for fish spawning, hatching, rearing and transport;
iii) improvement of gear and technique for collecting fry and fingerlings from natural waters;
iv) improvement in stocking techniques - optimum density and ratio for the possible combinations of fish suitable for culture;
v) correct use of fertilizers and supplementary feeds;
vi) effective control of noxious weeds, predators, disease and parasites;
vii) effective control of pond conditions.

d) Efforts to find more local fish suitable for stocking and culture should be intensified as follows:

i) in the case of those fish which have been shown to be suitable for stocking and culture purposes - Catlacarpio siamensis, Cirrhina microlepis and Cyclocheilichthys enoplos - the systematic survey of the occurrence (time and localities) of their fry and fingerlings should be intensified by:

i) setting up fry collecting bag nets designed especially for this purpose along the rivers to catch young fish;
ii) removing these fish from the net, preferably two to four times daily, to study them;
iii) this work should be started about the beginning of May and continued through September;
iv) the fry collected should be reared, each kind in a separate aquarium or tank, until they grow big enough for their identity to be established. Characteristics of the stages of growth should be observed and studied to find reliable and easily recognizable characteristics for field identification.

ii) Experiments to determine the suitability of other local fish for pond culture should be continued, with special attention on pla essok (Probarbus jullieni) and pla wien (Tor tembroides), two highly esteemed fish which are decreasing rapidly in their natural production. Fingerlings and/or young fish should be collected and kept under observation, first in a big aquarium or controlled tank, and later in controlled ponds. Their adaptability, mortality, food habits and rate of growth should be observed and recorded.

c) The excellent, though accidental, discovery by the fisheries officers at the Borapet Station of the natural spawning of Pangasius should be followed up by studies planned to gain fuller knowledge of the age, characteristics and habits of the spawning fish; frequency, season and location of spawning; conditions of spawning ground, etc. Experiments should be made to improve conditions of spawning ground to increase natural spawning, and simulation of conditions of natural spawning ground to induce spawning under controlled conditions.

4. Technical personnel

a) Most of the Thai fisheries officers are highly intelligent and are capable of efficient service when they are interested in the work. Therefore, ways and means to encourage real interest in their work should be considered.

b) Whenever possible, technical officers should be relieved of routine administrative duties to enable them to concentrate on technical activities.

c) Running the extension services from the office should be discouraged, and direct services, and field activities encouraged.

d) There is urgent need to continue the training of field officers and the senior fisheries officers are fully qualified technically to conduct such training. The enthusiasm of the instructors is of utmost importance - half-hearted teachers can seldom draw full-hearted effort from students.

e) Provision should be made for training young officers and new graduates in scientific investigation and experimental work. Opportunities should be provided for those thus trained to continue their technical activities.

5. Fisheries stations

a) The number of fisheries stations, including the field stations, is sufficient to service the Kingdom, at least for the present. Efforts should now be directed towards full development of the existing stations.

b) The four principal fisheries stations (Bangkhen, Borapet, Kwan Payao and Nong Harn) should undertake fundamental experiments and research, while the field stations should concentrate on extension service activities.